

# DBP: HALOACETIC ACIDS

## FACT SHEET



See related Fact Sheets: Acronyms & Abbreviations; Glossary of Terms; Cost Assumptions; Raw Water Composition; Total Plant Costs; and WaTER Program.

### 1. CONTAMINANT DATA

**A. Chemical Data:** Haloacetic Acids (HAAs) are a result of the disinfection process that forms these and other disinfection by-products (DBPs). HAAs are one of a family of organic compounds named as derivatives of a benzene ring. There are nine species of HAAs (HAA<sub>9</sub>), of which five species are currently regulated (HAA<sub>5</sub>):

HAA<sub>5</sub>: Monochloroacetic acid (MCAA), Dichloroacetic acid (DCAA), Trichloroacetic acid (TCAA), Monobromoacetic acid (MBAA), and Dibromoacetic acid (DBAA)

HAA<sub>9</sub>: HAA<sub>5</sub> + Bromochloroacetic acid (BCAA), Bromodichloroacetic acid (BDCAA), Dibromochloroacetic acid (DBCAA), and Tribromoacetic acid (TBAA).

HAAs are colorless, have a low volatility, dissolve easily in water, and are fairly stable.

**B. Source in Nature:** HAAs are not typically derived from natural sources. They form when a chlorine containing disinfectant reacts with naturally occurring organic matter, such as humic acids from decaying vegetation commonly found in raw water supplies, particularly lakes and reservoirs. The bromide containing species are influenced by the quantity of naturally occurring bromide in the water. Other major sources of HAAs in the environment come from chemical and pharmaceutical manufacturing processes such as, the bleaching of wood pulp by paper mills, the disinfection of drinking water and municipal wastewater upstream of the water treatment plant, and cooling water.

**C. SDWA Limits:** HAAs are one of four regulated DBPs. The MCL for HAA<sub>5</sub> is 0.06 mg/L (annual average). Significant monitoring requirements are also included in the SDWA regulations. The MCLG is 0.000 mg/L for DCAA and 0.3 mg/L for TCAA. Future regulations will likely reduce the TCAA MCLG to 0.02 mg/L and add an MCLG for MCAA of 0.03 mg/L.

**D. Health Effects of Contamination:** HAAs at short-term exposure levels above the MCL may increase the chance of spontaneous abortions in pregnant women, but evidence is inconclusive. At long-term exposure levels above the MCL, HAAs may cause an increased risk of cancer.

### 2. REMOVAL/REDUCTION TECHNIQUES

HAA control focuses primarily on:

- Removing HAA precursors
- Reducing the oxidant demand (e.g. NOM removal), and consequential reduction in dosage applied.
- Source water selection
- Optimization of the disinfection process

The removal of HAAs is usually a final solution when other methods can not achieve required reductions.

#### A. USEPA BAT:

##### NOM Removal

- Enhanced coagulation and media filtration for NOM removal uses the conventional treatment processes of chemical addition, coagulation, and dual media filtration. *Benefits:* low capital costs for proven, reliable process. *Limitations:* operator care required with chemical usage; sludge disposal.
- A granular activated carbon (GAC) filter can be used to remove NOM. GAC uses extremely porous carbon media in a process known as adsorption. As water passes through the media, the dissolved contaminants are attracted and held (adsorbed) on the solid surface. *Benefits:* well established; suitable for home use. *Limitations:* effectiveness based on contaminant type, concentration, rate of water usage, and type of carbon used; requires careful monitoring.

#### B. Alternative Methods of Treatment:

##### NOM Removal

- Enhanced coagulation and microfiltration (MF) or ultrafiltration (UF) for NOM removal uses the membrane filtration of coagulated NOM. *Benefits:* low capital costs for fairly new, but proven process. *Limitations:* higher operator care than for sand filtration, higher O&M costs.
- Ultrafiltration (UF) and nanofiltration (NF) for NOM removal uses the membrane to physically separate the NOM from the water. *Benefits:* less operator care than with coagulation and microfiltration, consistent low NOM product water. *Limitations:* membrane fouling, operator care, higher O&M costs than microfiltration, concentrate disposal.

## **B. Alternative Methods of Treatment: (cont)**

### NOM Removal

- Reverse osmosis (RO) for dissolved NOM removal uses a semipermeable membrane and high pressure pump to cause the water, but not suspended or dissolved solids NOM to pass through the membrane. Benefits: produces high quality water. Limitations: high cost; membrane fouling, pretreatment/feed pump requirements; concentrate disposal.
- Lime softening uses Ca(OH)<sub>2</sub> in sufficient quantity to raise the pH to about 10 to precipitate carbonate hardness and trap NOM in the process. Benefits: lower capital costs; proven and reliable. Limitations: operator care required with chemical usage; sludge disposal. pH readjustment needed.

### Source Water Selection

The selection of a source water, when possible, can significantly reduce HAA formation. The quantity and type of NOM in the source water impacts the amount of HAAs formed. The amount of bromide will affect the amount of brominated HAA species formed. The pH can affect the quantity and species of HAAs formed.

### Optimization of the Disinfection Process

The type and location of disinfection can greatly affect the amount and species of HAAs formed. This must always be checked against providing required CT values. When free chlorine is used, moving the disinfection point farther down in the process train will reduce HAA formation time. Also, if chlorination is after coagulation, there will be less NOM present to react with. Raising the pH before disinfectant addition lowers HAA formation, but may have other adverse effects on the treatment process. The most common modification of free chlorine to reduce HAAs occurs in converting free chlorine to chloramines in the distribution system. Chloramines have a very low HAA formation potential and are ideal for maintaining a constant chlorine residual. Changing the disinfection process to ozonation can be very effective in reducing HAAs, but it is fairly expensive and there is a problem with bromate formation in high bromide containing waters. Switching to UV disinfection eliminates all HAA formation and is less expensive than ozonation. A disinfectant residual using chloramines or free chlorine still needs to be provided in the distribution system for both ozone and UV treatment. Use of chlorine dioxide, a strong oxidant, does not produce significant HAAs, but will produce some amount of chlorite, which is a regulated DBP.

### HAA Removal

- HAAs can be removed by adsorption with an activated carbon filter (see “NOM Removal” section above).
- RO is also effective for HAA removal (see “NOM Removal” section above).

### Point of Use Systems

Solid block or precoated absorption filters made with carbon or activated alumina certified to reduce HAAs are available for point of use systems.

## **C. Safety and Health Requirements for Treatment Processes:**

Personnel involved with demineralization treatment processes should be aware of the chemicals being used (MSDS information), the electrical shock hazards, and the hydraulic pressures required to operate the equipment. General industry safety, health, and self protection practices should be followed, including proper use of tools.

## **3. BAT PROCESS DESCRIPTION AND COST DATA**

**General Assumptions:** Refer to: Raw Water Composition Fact Sheet for ionic concentrations; and Cost Assumptions Fact Sheet for cost index data and process assumptions. All costs are based on *ENR*, PPI, and BLS cost indices for March 2001. General sitework, building, external pumps/piping, pretreatment, or off-site sludge disposal are not included.

Refer to pages 9 of 12 through 12 of 12 for process descriptions and cost data.

## **4. REFERENCES**

### **USEPA BAT (Coagulation and GAC):**

<http://www.epa.gov/safewater/mdbp/stage1dbprwhatdoesitmeantoyou.pdf>

USEPA. The Stage 1 Disinfectants and Disinfection Byproducts Rule. What Does it Mean to You. EPA 816-R-01-014. June 2001.

<http://www.epa.gov/OGWDW/mdbp/dbpfr.html>

USEPA. National Primary Drinking Water Regulations: Disinfectants and Disinfection Byproducts; Final Rule. RIN 2040-AB82. 40 CFR Parts 9, 141, and 142. Section II E. December 1998.